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**FINAL REPORT**

**MSFC CONTRACT  
NAS8-38778**

FOR

**THE MICROGRAVITY PROJECTS OFFICE  
NASA MARSHALL SPACE FLIGHT CENTER  
MARSHALL SPACE FLIGHT CENTER, ALABAMA  
35812**

**CONTRACT PERIOD**

**May 1, 1992 Through September 30, 1995**

BY

**TEC-MASTERS, INC.  
1500 PERIMETER PARKWAY  
HUNTSVILLE, ALABAMA 35806**

**OCTOBER 23, 1995**

## TABLE OF CONTENTS

<u>SECTION NO.</u>	<u>TITLE</u>	<u>PAGE</u>
	PREFACE	iii
I.	INTRODUCTION	1
II.	CONTRACT STATEMENT OF WORK	2
III.	PRODUCTS (TASK NUMBER, DESCRIPTION, AND RESULTS)	4
IV.	CONCLUSIONS AND RECOMMENDATIONS	30

## PREFACE

This cost plus fixed fee (CPFF) level of effort contract was entered into as a four year effort in May 1992 between the National Aeronautics and Space Administration (NASA) Marshall Space Flight Center (MSFC) Microgravity Projects Office (MPO)<sup>1</sup> and Tec-Masters, Inc. (TMI) of Huntsville, Alabama. TMI was to provide mission support to the MPO during the time period of May 1, 1992, through April 30, 1996. However, MSFC desires to close-out all tasks under this contract by September 30, 1995 and in accordance with the request of the COTR the final report is being delivered at this time.

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<sup>1</sup>The Microgravity Projects Office was formerly known as the Microgravity Experiments Projects Office part of the Payload Projects Office.

## I. INTRODUCTION

This Final Report presents information on efforts accomplished by Tec-Masters, Inc. (TMI) relative to their mission support contract (NAS8-38778) with the National Aeronautics and Space Administration (NASA) Marshall Space Flight Center's (MSFC) Microgravity Projects Office (MPO). The efforts were worked in accordance with the contract's Statement of Work (see Section II of this Report) and per specific Task Orders as described in Section III. Section III presents a listing of each of the tasks performed along with information on task results. General information concerning the contract's Conclusions and Recommendations is given in Section IV.

Parts of this contract's efforts were performed by sub-contractors. The principal sub-contractor for this contract was CV Associates, Inc. of Huntsville, Alabama. Where germane to the task being discussed, the sub-contractor's role will be noted.

The expertise of the people working this effort ranged from program and technical levels to the office clerical level. Specifically, these people were; Project Manager, Senior Engineers, Staff Engineers, Engineers, Associate Engineers, Technicians, Illustrators, and Clerk/Typists. Efforts on this contract were accomplished both at the contractor's and sub-contractor's sites and at MSFC. This type working relationship between the government and the contractor helped to assure the efforts were accomplished in the best interests of the MPO.

## II. CONTRACT STATEMENT OF WORK:

1. The purpose of the NAS8-38778 contract as identified in the Statement of Work (SOW) is to provide planning, scientific, and engineering support to the NASA/MSFC Microgravity Projects Office. Work to be accomplished shall be initiated by individual task assignments.

2. The engineering functional support shall encompass the following broad technical areas: design, analysis, fabrication, test, general support, and provision of parts and supplies. Support in each of these broad areas shall be provided across the entire spectrum of technologies involving microgravity experiment definition and development. Design includes the development of concepts and specifications. Analysis includes the application and implementation of theory associated with the engineering mechanics of fluids, solids, composites, high temperature materials and experimental apparatus associated with same for ground and space based instrumentation. All analyses performed electronically on data processing equipment shall be readily transportable to the NASA/MSFC in electronic format with only minor editing requirements. System design tradeoffs and performance analysis shall be performed on existing and conceptual systems. Fabrication includes all labor and parts required to deliver a finished product as defined by the task order. Fabrication capabilities shall encompass all techniques and processes necessary to perform the construction of modern aerospace structures, components, subsystems, and systems including the electronic devices required for their operation and functionality. The test area includes all aspects of testing from the establishment of the test requirements to final reporting of the effort. Tests must be planned, resources obtained, testing executed, and the results or data analyzed and presented. General support is all efforts performed in conjunction with, and incidental to the performance of technical tasks as outlined in this procurement. General support shall include all aspects of program planning, execution, reporting, database generation, and data manipulation. Provision of parts and supplies includes costs to obtain these items from a supplier.

3. Work required under this contract shall consist of performing in the following general technical areas as specified by specific tasks orders. These general technical areas are: (1) Engineering Mechanics - Fluids, Structural, Solids, Fracture and Penetration; (2) Electronics and Electrical Analysis and Control Theory, specifically as it applies to experiment (instrument) status sensors and safety warning devices, (3) Thermodynamics and Heat Transfer; (4) Composites, Metallurgy and Chemistry; (5) Dynamics, Vibration, Modal Analysis, and Simulation; and (6) Project/Systems Engineering. These technical areas or disciplines shall be applied across the broad areas and mission responsibilities.

4. Efforts shall include development of components, subsystems, and systems within the above technical areas. These activities shall include:

- Design/design analysis/fabrication
  - Breadboard
  - Brassboard
  - Prototype
  - Special purpose test apparatus
  - Data acquisition instrumentation
  - Modification and/or repairs
- Test Planning/Conduct
  - Laboratory (development and safety)
  - Flight
- Data acquisition/reduction/analysis
  - Simulator
- Development
  - Integration
  - Modification
  - Validation
- Operational
  - Theoretical Investigations
- Component/system assessment
  - Performance determination
  - Evaluation and comparisons.

The above activities shall apply to all phases of the R&D cycle as required and include:

- Exploratory/advanced research
- Engineering development
- Technology demonstration/inspection
- Risk reduction.

5. The contractor shall also provide supporting technical analysis/evaluation for Design Reviews.

6. Upon receipt of a task assignment, the contractor shall have five working days to respond with a "Technical Performance Plan". This plan shall contain (a) how the work will be accomplished, (b) who (key personnel) shall accomplish the work, (c) a schedule with appropriate milestones for completing the work in a timely manner, and (d) manpower/cost estimate.

### III. PRODUCTS (TASK NUMBER, DESCRIPTION, AND RESULTS):

Task Order Number: 001:

Description: The contractor shall provide planning and engineering support to the NASA/MSFC Payload Projects Office, Microgravity Experiments Project Office in support of the GLOVEBOX Experiment.

The contractor shall design and fabricate facility enhancements per Government specifications to support the GLOVEBOX Experiment. The contractor shall support program planning, reporting, and data manipulation requirements for the experiment. Provision of parts and supplies shall include costs to obtain those items from a supplier.

Status/Deliverables: TMI investigated the feasibility and cost benefit of consolidating project and technical management of several microgravity acceleration projects at MSFC. Research focused on identifying the scope of effort and impact of transferring management of OARE, SAMS, and SAMS-SSF to MSFC. The research included conducting meetings and interviews with managers, engineers, and scientists of PPO, MSFC S&E, MSAD, JSC, and LaRC to determine operational and support requirements of the systems and to provide cost estimates for the transition, integration, and subsequent operation and maintenance of the systems. Based on results of the above investigation, a briefing was drafted and delivered in January 1992 presenting proposals, transition concepts, and cost benefit analyses for the consolidation of the acceleration projects at MSFC. Reports on the progress of development of acceleration measurement technologies at JPL and LaRC were also delivered in January 1992.

Glovebox and PCG project decals, posters, and patches were ordered and delivered in May 1992 for distribution to interested parties in the scientific community to instill interest in the public sector in the space program. Glovebox wall duratrans were designed, drafted, produced, and delivered in January 1993 for use at NASA Headquarters and in conference rooms. Graphic representations of the Microgravity Glovebox Facility were designed and computerized for view graphs in support of project meetings.

Per NASA direction, this task was closed in February 1993 and this analysis continued under task 010.

Task Order Number: 002:

Description: Provide the necessary engineering and equipment to develop a Video Microscopy system for the Holography Ground System (HGS) located in MSFC Building 4708.

Coordinate with Mr. David McIntosh, MSFC, Experiments & Components Test Branch (EL64), Telephone No. 544-1362, for technical information. This task is not quality sensitive.

Status/Deliverables: The work under this task was performed with a sub-contract to CV Associates, Inc. A study was made to develop a Video Microscopy System for MSFC's Holography Ground System. The necessary adapter components and video camera specifications were refined and compiled into a system specification for purchase. The components were procured, integrated, and delivered in August 1992.

Task Order Number: 003:

Subtask Number: 1:

Description: Provide support to the Microgravity Systems Office (JA84) in a broad area of technologies for flight experiment definition and development. This will include development of concepts and specifications for the modification of existing protein crystal growth apparatus.

Status/Deliverables: The work under this sub-task was performed with a sub-contract to CV Associates, Inc. An in-depth study was performed to evaluate a new European designed Borack Freezer/Cooler for possible Shuttle Middeck flight to support Advance Protein Crystal Growth (APCG) experimentation. Two possible mounting locations in the Middeck were evaluated - the Middeck locker area and a new Middeck Accommodations Rack (MAR). Findings of this evaluation were compiled into a comprehensive report entitled, "Investigation of IML-2 Freezer/Cooler for Possible Shuttle Middeck APCG Experiment Utilization", and was delivered in August 1992.

Subtask Number: 2:

Description: Provide technical support to the Microgravity Systems Office (JA84) to evaluate status of data analyses from the Fluid Experiment System (FES)/Vapor Crystal Growth System (VCGS) and make recommendations for additional analysis.

Status/Deliverables: The work under this sub-task was performed with a sub-contract to CV Associates, Inc. A draft Statement of Work (SOW) was prepared for the design and development of a Glovebox for a proposed flight in the Shuttle Middeck. This detailed draft SOW was completed and delivered to the requester in August 1992. CV Associates, Inc. performed an analysis of low-g accelerometer data relative to Fluid



Experiment System (FES) experiment operations on the IML-1 mission. This work was undertaken in an effort to determine if abnormally low-g accelerations during the mission were responsible for anomalies which occurred during FES/Triglycine Sulfate (TGS) experiment operations. All data analysis efforts under this task were terminated and transferred to Task Order 006 per direction of NASA.

Subtask Number: 3:

Description: Contractor shall review and make recommendations on GFFC re-certification including re-assembly and testing for reflight.

Status/Deliverables: The work under this sub-task was performed with a sub-contract to CV Associates, Inc. A comprehensive review was made on a revised edition of the Geophysical Fluid Flow Cell (GFFC) Operations and Maintenance (O&M) Manual. Results of the review were compiled into a detailed report and delivered per contract requirements in December 1992.

Task Order Number: 004:

Description: Provide Engineering and Project support to APCG, including the analysis and/or feasibility of flying an APCG experiment on board the Russian Mir (Space Station) in the 1995 timeframe. This analysis shall include supporting the development of cost and schedule data. The contractor shall also provide engineering analysis, as required, on selecting various flight concepts of the APCG.

Status/Deliverables: The work under this task was performed with a sub-contract to CV Associates, Inc. CV Associates, Inc. provided information, schedules, and cost estimates to fly Advanced Protein Crystal Growth (APCG) experiments during a 1994/95 joint Shuttle/Russian Space Station Mir Mission. Four different mission scenarios were evaluated, man loaded, and costed for an MSFC proposal. Informal oral and written inputs were transmitted to MSFC on a daily basis. In addition, a quick-response survey was made of an extensive list of possible scientific investigators for possible protein crystal growth candidate experiments for a joint mission. The results of the survey were compiled to aid MSFC in a proposal to NASA Headquarters.

CV Associates, Inc. reviewed the proposed flight opportunity feasibility of Advanced Protein Crystal Growth (APCG) experiments on the Russian Mir Space Station. The report "Protein Crystal Growth (PCG) Feasibility Study for a Joint Spacelab/Mir Mission in 1995" was produced and delivered in February 1993.

An evaluation of the revised proposals from the University of California at Riverside (UCR) and the University of Alabama, Birmingham (UAB) was accomplished resulting in the generation of three reports delivered in March 1993 as follows:

1. "Evaluation of Proposal for the UCR Protein Crystallization Experiments on IML-2 in the ESA Advanced Protein Crystallization Facility dated January 29, 1993 and February 1, 1993"
2. "Evaluation of Proposal for the Development of an Advanced Liquid-Liquid Diffusion Instrument for Protein Crystal Growth in Microgravity Based on the ESA APCF Design dated January 29, 1993, and February 1, 1993"
3. "Evaluation of Microgravity (PCG-M) Project in Response to NASA/NRA-91-OSSA-18 (Proposal dated February 1993)".

Task Order Number: 005:

Description: Provide engineering and project support to the Microgravity Systems Office (JA84) in a broad area of technologies for Protein Crystal Growth (PCG) flight experiments, including operations definition, development, and technical documentation. The definition phase shall include establishing hardware requirements for various proposed mission profiles such as the Russian Mir, Middeck, and Space Station facilities/accommodations. Baselines shall be established to define the hardware required along with appropriate documentation to implement the project phase.

Status/Deliverables: The work under this task was performed with a sub-contract to CV Associates, Inc. Statements of Work were prepared for five potential contracts to be awarded to both University and Government organizations as a result of NASA Research Announcement NRA-91-OSSA-18.

CV Associates, Inc. reviewed preliminary Science Requirements Documents (SRDs) and produced reports delivered in January 1993 entitled "Summary of Comments and Recommendations on the Preliminary Science Requirements Document for Development of an Advanced Liquid-Liquid Diffusion Instrument for PCG in Microgravity Based on the ESA APCG Design" and "Summary of Comments and Recommendations on the Preliminary Science Requirements Document for Development of an Observable Protein Crystal Growth Apparatus (OPCGA)".

CV Associates, Inc. reviewed the preliminary Science Requirements Documents (SRDs) submitted by Dr. Daniel Carter and the University of Alabama Birmingham (UAB). The review of Dr. Carter's document was completed and delivered to MSFC in February 1993 under the title of "Summary of Comments and Recommendations on the

Preliminary Science Requirements Document for Protein Crystal Growth Vapor-Diffusion Flight Hardware and Facility". The review of the UAB SRD was completed and delivered to MSFC in March 1993 under the title of "Summary of Comments and Recommendations on the Preliminary Science Requirements Document for Protein Crystal Growth Developments as a Result of NASA Research Announcement NRA-91-OSSA-18".

Task Order Number: 006:

Description: Provide technical and project support to the Microgravity Systems Office (JA84) for establishing technical documentation (project plans, specifications) for the Middeck Glovebox Program. Perform engineering analysis (data reduction) of the accelerometer data received from the FES/VCGS flight experiment (ML-1).

Status/Deliverables: The work under this task was performed with a sub-contract to CV Associates, Inc. A low-g accelerometer data analysis effort was initiated and areas of interest identified relative to the IML-1 Mission Fluid Experiment System (FES). Accelerometer raw and rms data were obtained to aid in identifying sources of perturbations which occurred during FES operations. CV Associates, Inc. performed a preliminary analysis of data plots of yaw, pitch, and roll in an effort to more closely focus the analysis on key areas of interest to the principal investigators. Triglycine sulfate (TGS) hologram analyses (particle movement plots) were performed by Drs. Lal and Batra of Alabama A&M University. Spectral analysis plots were produced by NTI for comparison with the TGS hologram analysis plots. The data derived from these analyses was compiled in the report entitled, "Technical Report: IML-1/FES Low-g Accelerometer Data Analysis". The data from each analysis was included as appendices to the report delivered in May 1993 as follows:

1. RAW Acceleration Data
2. RM Acceleration Data
3. (10 second) Average Acceleration Data
4. Pitch, Yaw, and Roll Data
5. TGS and CAST Mode Times for IML-1
6. TGS Holographic Sequence Tables
7. (10 second) Average Acceleration Data for TGS Runs 1 and 1C (20 minutes per plot)
8. Spectrum Level Plots from 0 to 100 Hz for TGS Runs 1 and 1C (10 minutes represented per plot).

Task Order Number: 007:

Description: Contractor shall review GFFC recertification documentation and support the reassembly and testing for reflight.

Status/Deliverables: This task was canceled as of January 1993 when a determination was made that this work was covered under another task.

Task Order Number: 008:

Description: Recommend U.S. Microgravity experimenters with whom collaborative investigations would benefit MSFC and document their topics for proposed investigations. Identify investigators, purpose of experiments, experiment conditions, and scientific objectives. Identify the premier organizations, to include universities and industry, conducting research in material science and microgravity experiments. Identify potentials for joint mission and technology/research transfer. Prepare briefing charts and monthly technical reports as required by the task and contract.

Status/Deliverables: TMI surveyed and documented topics relative to U.S. Microgravity Experiments and Research. Information was prepared on several topics to be used by MSFC researchers and spaceflight personnel to brief academia and industry laboratories. TMI supported the research by querying several existing experiment databases and submitting key words to the Redstone Scientific Information Center Library. A senior scientist, Dr. Byron Lichtenberg, assisted as a consultant in the research and provided a report detailing the findings and assessment of the research. This report, entitled "U.S. Microgravity Experiments Survey", was delivered to MSFC in July 1993. It included a briefing outline for potential use during symposia to solicit outside investigators interested in collaborating with NASA, a listing of ESA and Japanese areas of microgravity research interest, a listing of "hot" areas in materials science, and a listing of potential research collaborations in academia and other labs.

Task Order Number: 009:

Description: The contractor shall review and support the finalization of "Mechanics of Granular Materials" (MGM) documentation such as the Science Requirements Document (SRD). The contractor shall use system design trade-offs and performance analysis to recommend hardware developmental approaches. The contractor will perform a study to determine from a Payload Element Developer's (PED's) perspective the unique cost

elements and difference associated with flying on different carriers (i.e. Middeck, Spacelab, Spacehab, and SMIDEX Rack).

Status/Deliverables: The work under this task was performed with a sub-contract to CV Associates, Inc. A review was made on the Mechanics of Granular Materials (MGM) Experiment Preliminary Science Requirements Document (SRD) dated September 1991. A preliminary summary of comments and suggestions was compiled and delivered to MSFC. The contractor performed a payload carrier cost study. The study was done in phases with the first phase consisting of assessing and categorizing the carrier mission requirements imposed on the users. The "Delta Payload Mission Manager Integration Requirements Template" was compiled from the results of phase I and delivered to MSFC in October 1993. The second phase consisted of preparing detailed manpower and cost estimates based on the mandated user requirements for five mission management scenarios. The last phase consisted of surveying and interviewing many prior Shuttle Middeck users. Questionnaire materials were compiled and delivered to MSFC in October 1993 for distribution. The data from this study was analyzed and summarized in the report entitled "Middeck Carrier Cost Study - Final Report". This report was reviewed with various MPO personnel and all comments incorporated prior to delivery in March 1994. Presentation material from this report was also generated and delivered to MSFC in March 1994.

Task Order Number: 010:

Description: Collect information and prepare briefing charts for a MSFC proposal to manage the space acceleration projects (SAMS, SAMS-SSF, ACAP, OARE). Support the proposal activity as required with travel or supplemental effort. Provide briefing materials and data management as required.

Contractor shall deliver equipment sufficient to generate presentation materials as outlined in the Task Description.

Status/Deliverables: This task was a continuation of the work that was being done under Task Order 001. The draft briefing delivered in January 1992 under Task Order 001 presenting proposals, transition concepts, and cost benefit analyses for the consolidation of several space acceleration projects at MSFC was reviewed with MSFC personnel and the comments incorporated for a presentation to NASA Headquarters. Comments continued to be incorporated with the final version delivered to MSFC in April 1993. Administrative support was provided for the 3rd Annual European/MSFC Microgravity Engineering

Meeting held in Huntsville, Alabama during November 1993. A report on the meeting was produced and submitted to MSFC in January 1994.

Task Order Number: 011:

Description: Provide materials and labor to fabricate and assemble an aluminum rack as specified in drawings furnished by MSFC/Space Station & Commercial Applications Office (JA82). This rack will be a working example for fit-checking payload requirements, but will not compete with the Space Station rack design. The aluminum rack assembly will reside in the Microgravity Development Complex at MSFC.

Status/Deliverables: An aluminum rack was fabricated and assembled per specifications from the Space Station & Commercial Applications Office (JA82). The approved vendor was Banner Machine. The rack was delivered to the Microgravity Development Complex in December 1993.

Task Order Number: 012:

Description: Provide engineering, design, hardware development, and project management support to the Microgravity Systems Office (JA84) in a broad area of technologies for Protein Crystal Growth (PCG) flight experiments. This support shall include operations, technical and contractual documentation, and project definition. Specifically, the project management support shall be provided for the joint NASA/Russian Space Station (Mir) activities.

Status/Deliverables: The work under this task was performed with a sub-contract to CV Associates, Inc. An analysis was performed on the design of the Thermal Enclosure System (TES) and possible modifications to improve the operating level of the unit were suggested. The TES analysis resulted in a report delivered in April 1993 entitled "TES Thermal Improvement Analysis". Continued analysis of the design of the TES resulted in the report entitled "TES Electrical System Supplementary Report" that was delivered to MSFC in May 1993.

Alternative methods of refrigeration that could be used in the Shuttle Middeck for Protein Crystal Growth experiments were investigated and summarized in the report delivered in April 1993 entitled "Quick Look Interim Report - Investigation of New Refrigerator Techniques for PCG Spaceflight". A comprehensive report on new refrigeration technology entitled "Evaluation of New Refrigeration Techniques for Possible

PCG Spaceflight Applications" was compiled from the continued investigation into alternative refrigeration techniques and delivered in June 1993.

One of the statements of work entitled "SOW for Observable Protein Crystal Growth Apparatus (OPCGA) through Conceptual Design Review with Contract Options" delivered under Task Order 005 was revised per direction from MSFC. It was re-submitted in May 1993 for further review by Dr. Alex McPherson of the University of California, Riverside (UCR) and by additional MSFC personnel. UCR submitted a revised proposal in response to the updated SOW. This proposal was reviewed and a report submitted in November 1993 entitled "Evaluation of Proposal for an Observable Protein Crystal Growth Apparatus (OPCGA) by the University of California, Riverside (UCR)". Another statement of work entitled "SOW for the University of Alabama, Birmingham (UAB) PCG Developments as a result of NASA Research Announcement NRA-91-OSSA-18" delivered under Task Order 005 was revised per direction from MSFC. It was re-submitted in July 1993 with a final revision delivered in October 1993. The statement of work entitled "SOW for UAB Protein Crystal Growth Investigation (Rev. in New Format)" was revised and delivered to MSFC in July 1993 as Rev. A. The UAB SOW for a proposed new Protein Crystal Growth (PCG) flight program was updated and submitted in January 1994.

Task Order Number: 013:

Description: Develop a series of visual aids, presentation charts, and a general lesson plan for use in depicting the process and benefits of growing protein crystals in space. The materials should clearly establish the relationship of the activity to the advancement of general science and the benefit to the public. The product should be organized such that it may be presented to non-technical groups as well as science classes at the high school level.

Status/Deliverables: Ms. Judy Spiller, as a consultant on this contract, researched the Redstone Scientific Information Center (RSIC) for applicable PCG publications, studied selected published articles and presentations, viewed PCG videos, and conferred with PCG personnel at MSFC. She drafted microgravity lab exercises for use in physical science and/or biology classes. Ms. Spiller, with the assistance of TMI personnel and equipment, developed color transparencies for use with a classroom unit and a "general public" presentation. The PCG presentations for classroom and "general public" use were completed and delivered to MSFC in December 1993.

Task Order Number: 014:

Description: Provide technical writing support on a paper on microgravity to be given at Florence, Italy.

Provide a seven-minute video covering Materials Science and Biotechnology research for the Microgravity Science and Applications Division Teleconference. Amend the current video to include the attached topics.

Status/Deliverables: Mr. Dave Dooling, as a consultant on this contract, provided technical writing support to the Microgravity Projects Office. The technical writing support resulted in a paper delivered in August 1993 for presentation by the Manager of the Microgravity Projects Office at the Spacelab Conference held in Florence, Italy during October 1993. The paper was revised and delivered in September 1993 for presentation as a speech with viewgraphs. Mr. Dooling also developed the associated viewgraphs.

Mr. Dooling, working closely with the manager of the Microgravity Science & Applications Division, assisted with the outline and script development in support of the video on Materials Science and Biotechnology research for the Microgravity Science and Applications Division Teleconference. Mr. Dooling produced a printed handout to accompany the video. The TMI video production team recorded the narration by the Manager of the Microgravity Science & Applications Division, filmed video footage at the University of Tennessee Space Institute in Tullahoma, Tennessee, incorporated footage requested from various NASA Centers, and produced the video shown at the Microgravity Science and Applications Division Teleconference. The completed video and handout were delivered to the Space Science Laboratory at MSFC in December 1993.

The TMI video team researched information on additional topics that was added to the original video. The research resulted in an outline and script for the video extension which was discussed with the manager of the Microgravity Science & Applications Division definitizing the video contents. Technical direction from the manager of the Microgravity Science & Applications Division continued during production of the extended version of the video. In January 1995 the format and focus of the video was modified for inclusion in a NASA PBS teleconference broadcast in May 1995. The video was modified to focus on Protein Crystal Growth and included an additional narrative from the Manager of the MSFC Biophysics Branch and additional laboratory footage. The video footage was sent on April 25, 1995 to the television station in Virginia that was to air the PBS broadcast and a copy of the final video resides in the Microgravity video reference library.



Task Order Number: 015:

Description: Provide engineering and project management support to the Microgravity Systems Office (JA84) in a broad area of technologies for Protein Crystal Growth (PCG) flight experiments. Specifically this support shall include, but not be limited to, the joint NASA/Russian Mir mission. This support shall include: project definition, document analysis and preparation, logistics, training, and hardware integration. The project management support shall also include providing expertise on Russian Hardware availability, guidance on Russian documentation requirements, and Russian Spacecraft Capabilities and environments.

Status/Deliverables: Dr. Byron Lichtenberg and Ms. Julianne Zimmerman in conjunction with Payload Systems, Inc. personnel researched documents that defined the PSI/NPO Energia working relationship. The team also investigated the materials research facilities on Mir and contacted Russian scientists in the PCG area. The research was completed and a report entitled "The Joint NASA/Russian Protein Crystal Growth Mission Guideline Study" was delivered with a formal presentation to MSFC in January 1994.

CV Associates, Inc. researched the available Russian PCG-related hardware and capabilities. Information was obtained on the basic science program along with present schedules and milestones in order that project management support could be supplied in a timely manner. CV Associates, Inc. explored the feasibility of NASA obtaining selected Russian Hardware for either ground or flight use. A report entitled "Interim Report on Russian Microgravity Equipment" was delivered to MSFC in February 1994.

Dr. Aksamentov visited Moscow where he met with specialists affiliated with both the Moscow Aviation Institute (MAI) and NPO Energia. Topics of discussion at these meetings were associated with capabilities of KRISTAL and SPEKTR to accommodate microgravity type experiments. This exchange included the micro gravitational levels during experiment operation and the methods used to determine these levels during experiment operation and the methods used to determine these levels at various positions. Various other individuals of leading Russian organizations were contacted. The information gathered with this research was detailed in a report summary on Russian Microgravity Equipment that was delivered to MSFC in June 1994.

Task Order Number: 016:

Description: Provide management/administrative functions to include but not be limited to planning, organizing, coordinating, controlling, directing, and reporting contract activities.

Status/Deliverables: Management and administrative support was provided for each task under this contract. The support included planning, organizing, coordinating, controlling, directing, and reporting task activities. Monthly technical and financial reports were produced and delivered to MSFC.

Task Order Number: 017:

Description: The Contractor will provide planning and engineering support to the Microgravity Science Glovebox (MSG) in a broad area of technologies for flight experiment definition and development. This will include the development of concepts and specifications for the MSG as well as technical documentation. The Contractor will provide engineering analysis and planning support.

Status/Deliverables: TMI supported the Microgravity Projects Office (MPO) in the definition and production of a development plan for the Microgravity Science Glovebox. The document entitled "Development Plan for the Microgravity Science Glovebox (MSG)" was developed and delivered to the Microgravity Projects Office in December 1993. A presentation on the plan was developed for the MPO in December 1993 including the production of the charts.

Task Order Number: 018:

Description: The Contractor will provide assistance in the implementation, operation, and maintenance of a technical reference library for the Microgravity Projects Office (MPO). The work will include the determination of the library structure, the setup of the library, the development of an automated system for reference information and tracking of documents, and the support of the library functions. These functions include receiving, cataloging, warehousing, updating, and maintaining the documents contained in the technical reference library.

Status/Deliverables: A copy of Filemaker Pro version 2.1 for the Macintosh was purchased and delivered to the MPO for use in the Microgravity Technical Reference Library. Potential technical reference library patrons from the MPO were surveyed to determine the requirements for an automated document tracking system. These requirements were organized and reported in the Microgravity Technical Reference Library Requirements Document. This document was delivered to the MPO in March 1994. The tracking system was developed using Filemaker Pro to run on a Macintosh. The system

provides the capability to ensure the latest version of all technical reference documents are on file. The system tracks document usage and patron information.

Task Order Number: 019:

Description: The Contractor will provide general management support particularly in the area of document preparation. The Contractor will assist in the definition and documentation of management plans, development plans, implementation documents, etc.

Status/Deliverables: The MSAD Management Plan was reviewed and redline comments were delivered in April 1994. Extensive effort went into researching and developing a draft management plan for the MSFC Microgravity Projects Office which was delivered in September 1994. The Microgravity Projects Office Implementation Plan was developed and delivered in September 1994. Two versions of the "Mechanics of Granular Materials (MGM) Science Requirements" document were reviewed resulting in a change report being developed and delivered in September 1994. An effort was initiated to determine the relationship between Protein Crystal Growth and Fluid Flow. The effort was defined and the required research was outlined in a draft document delivered in February 1995.

Task Order Number: 020:

Description: The Contractor will provide assistance to the Microgravity Projects Office in the development of research reports to be presented at professional conferences and symposia throughout the year. The work will include monitoring submissions by scientists, selecting appropriate papers in concert with Microgravity Projects Office managers, and developing written summaries in illustration concepts for pre-conference release. The Contractor will also assist with the collection of data and preparation of reports to be provided to other NASA organizations.

Status/Deliverables: Mr. Dave Dooling, a TMI consultant, worked with the Microgravity Projects Office Manager in developing a paper for presentation at a space conference in Canada. The paper was delivered in February 1994. Mr. Dooling supported the microgravity sciences conference in Huntsville in preparation of the development of articles for the MSAD newsletter which was delivered in May 1994. Mr. Dooling supported the IML-2 mission and simulation conferring with mission managers on planned activities for filing daily reports with NASA Headquarters. Mr. Dooling reviewed fact sheets from PAO on the mission. A press release was prepared during September 1994

describing MSAD related papers for an AIAA conference. A press release and fact sheet were prepared in April 1995 on a glovebox experiment being prepared for Mir. Fact sheets on USML-2 PCG and VDA-2 were prepared and delivered in September 1995.

Task Order Number: 021:

Description: The Contractor will identify and document microgravity flight experiment activities conducted, and being conducted, by Russia with emphasis on biotechnology and materials processing of semiconductor and optical materials. The work will include the locations of said research, the Investigators conducting the research, the sample materials under study, the experiment hardware used to conduct the flight experiments, and where possible, what was learned from each flight activity. In addition, this task will address the integration and operation of candidate U.S. payloads on joint U.S./Russian missions. The result will be formatted such that it can be directly incorporated in the SPACECOM Database.

Status/Deliverables: Teledyne Brown Engineering was sub-contracted to assist with the research on this task. An analysis was made to determine the type of information/data that could be considered necessary and sufficient to provide U.S. experimenters with reasonable insights into the Russian experiment hardware systems which are planned for use. The information/data of most value to the U.S. experimenter consists of the following: flight hardware name, technical use of the flight hardware, Principal Investigator(s) who have utilized the flight hardware, flight hardware characteristics (physical, electrical, operational), compatible flight hardware carrier(s), organization(s) responsible for applications of the flight hardware, and flight hardware manufacturer. The information and data gathered on each payload was put into a one-page format in order to permit an easy assessment to be made of the payload characteristics, capabilities, and applications. This concise data format enables U.S. experimenters to decide, at the very top level, if the experiment hardware/facilities used in Russian microgravity initiatives would be suitable for their own flight projects. It also provides a basis for assessment of the relevance of Russian flight investigations to their own fields of research. No contact was made with the Principal Investigators or other key personnel and some of the data was not found in the available literature. The available information/data items identified above were gathered, compiled in matrix form, and delivered to MSFC in October 1994. This data was also entered into the SPACECOM Database. Data was gathered on a total of thirty-one payloads/experiment facilities.

Task Order Number: 022:

Description: The contractor will assimilate and access the gravity level requirements for the driving phenomena associated with conducting research in biotechnology and materials processing of semiconductor and optical materials in the low gravity environment of low Earth orbit. The results will be compiled and documented such that they can be used as design guidelines for experiment hardware development and to project requirements into the design of accommodating vehicles in order to conduct research in the above areas.

Status/Deliverables: Teledyne Brown Engineering was sub-contracted to assist with the research on this task. A comprehensive list of publications, research papers, and analytical, modeling, and test reports available since the 1988 Microgravity Crystal Growth Workshop was generated. The list contains over 100 references. A review of this documentation led to the conclusion that the information available in the vast body of this literature needs to be consolidated in order to extract a comprehensive set of acceleration environment requirements and constraints for application to the various materials processed and crystal growth techniques employed in space. A list of all of the documentation identified was submitted to MSFC in October 1994.

Task Order Number: 023:

Description: The contractor will analyze microgravity materials science ground based and flight definition programs managed by MSFC, and identify & document projected flight requirements of the research efforts that may develop. These anticipated flight requirements will be analyzed against capabilities of the Express Rack Program and Shuttle Middeck to determine which research efforts, if successfully carried to flight, can be accommodated by Express Rack or middeck. A strawman traffic model will be developed displaying a potential process for accommodating these experiments. The contractor will also analyze these projected flight requirements against the availability and utility of existing flight hardware in other programs such as NASA's commercial flight program, Canadian Space Agency, NASDA, CNES, Dornier, MBB/EER, ESA, Russia, etc. In addition, the contractor will support the Project Office in interacting with the Express Rack Program to assure that these requirements are appropriately considered for flight.

Status/Deliverables: TMI acquired copies of technical information of all appropriate ground based research managed by MSFC. TMI participated in a two day Express Rack

Meeting in support of Furnace Development Office (FA24) in March 1994. TMI collected, assembled, and organized information concerning microgravity experiment hardware from the CSA, NASDA, ESA, Dornier, CNES, Russia, MBB/ERNO, etc. The work under this task was transitioned into task 40 beginning in June 1994.

Task Order Number: 024:

Description: Perform computational analysis of the protein crystal growth Thermal Enclosure System (TES) and access system thermal performance relative to the Space Shuttle thermal environment.

Status/Deliverables: CFD Research Corporation, as a sub-contractor to TMI, provided the expertise required to perform the computational analysis of the protein crystal growth TES. The results of the analysis were compiled and published in a document entitled "A Thermal Analysis of the Thermal Enclosure System (TES)". The document was delivered to MSFC in March 1994.

Task Order Number: 025:

Description: The Contractor will provide management support to the Microgravity Data Center. This support includes coordinating general activities for the Data Center, maintaining service logs, and producing metrics charts for Center operations, supporting all database activities within the Data Center operations, advising and representing the Microgravity Projects Office in various activities, and serving as the point of contact for Data Center users and for the Project Office. The Contractor will also support the further development and enhancement of the Ground-based Experiments Document Collection, to include collecting, assessing, cataloging, and indexing documents related to MSFC ground-based experiments. The Contractor will maintain collections and databases for photo/visual aids, responding to user requests for such, and actively procuring new additions to the photo/visual aids collection.

Status/Deliverables: The Microgravity Data and Information task was transitioned from the Essex Corporation to Tec-Masters, Inc. (TMI) during March 1994. The TMI team officially assumed responsibilities on April 1, 1994. TMI personnel provided support to the Microgravity Development Complex (MDC) Product Development Team (PDT). TMI represented MSFC at the 2nd Annual Catalog Interoperability/NASA Science Internet Workshop. Ground-based Experiments Documentation continued to be collected, organized, filed, and added to the database index. Procedures for locating and retrieving

ground-based experiment documents were developed and reviewed by all Microgravity Data and Information Center (MDIC) personnel. TMI inventoried video tape holdings versus the video database and made necessary corrections. Work began on an inventory of photograph holdings versus the photograph database. TMI began designing the new user interface of the ground-based experiment documents database and the video/photograph database. TMI assisted MSFC users with video and photo requests. A system was designed to maintain a record for tracking and reporting Data Center activity.

Task Order Number: 026:

Description: The Contractor will continue the development of a microgravity science data archive for the Microgravity Projects Office. This effort includes the creation of a local directory of Experiments Data Management Plans; identifying data locations; development of a user interface to the directory; collecting, cataloging, and indexing data; performing data entry; providing user services; and collecting metrics on database usage.

Status/Deliverables: The Microgravity Science Data Archive task was transitioned from Essex Corporation to Tec-Masters, Inc. (TMI) during March 1994. The TMI team officially assumed responsibilities on April 1, 1994. NASA Headquarters approved, with minor changes, the thirty-nine Data Interchange Forms (DIF's). The changes were included in the database. TMI provided input for the 2nd Annual Catalog Interoperability/NASA Science Internet Workshop and continued providing input for the monthly Catalog Interoperability teleconference. The Microgravity Science Data Archive (MSDA) was upgraded to FoxPro for Windows Version 2.6. The MSFC MSDA database was restructured to minimize duplication of information and to increase efficiency. TMI personnel accompanied the MSFC team on a trip to the Washington, DC area to visit NASA Headquarters, GSFC, and the Center for Advanced Research in Biotechnology (CARB) in June 1994. The trip opened communication and allowed MSFC to gather more information on the interface with the Master Directory at GSFC. TMI designed and developed a program module to create the Date Interchange Format (DIF) file from the database to send to the Master Directory. They also developed the interface for electronically transmitting the data to GSFC. TMI gained access to the INTERNET via the local MSFC network for viewing the GSFC Master Directory. A working prototype of the MSDA Tracking System was designed and developed. This system added a required graphical user interface to the archive database.

Task Order Number: 027:

Description: The Contractor will assist with the transition of responsibilities and office files for the preparation of the Space Science Laboratory monthly report and the MSFC Microgravity Annual Report as well as other duties associated with the preparation of these reports from the current contractor.

Status/Deliverables: The work was transitioned from the previous contractor during March 1994. TMI provided photographic materials to the Microgravity Projects Office (MPO). TMI also provided logistics support to the MPO for the MSFC Microgravity Materials Science Conference.

Task Order Number: 028:

Description: The Contractor will develop a 3-4 minute video on the AADSF for use by NASA Headquarters for Congressional presentations. The video should cover the subject material at a level easily understood by non-scientific viewers.

Status/Deliverables: TMI developed an outline and script for the video and had them reviewed and approved by MSFC. TMI also recorded the narration and taped interviews with key personnel. A computer model of the AADSF was converted to video. The video footage was compiled, edited, and delivered to MSFC in May 1994. A copy currently resides in the Video Reference Library at MPO.

Task Order Number: 029:

Description: The Contractor will provide planning support for the Microgravity User Operations Facility (UOF) and Space Station operation. This support will include discussions with users, coordination of tasks, and attendance at reviews (design/tabletop). Other activities include assessment of concept maturity, and detailed technical work such as the analysis of connectivity, preparation of presentations, and participation in telecons, design reviews, video conferences, workshops, and working group meetings at various locations. These activities involve a variety of projects assigned to MSFC/FA23 including small flight hardware projects, and other similar assignments.

Status/Deliverables: TMI purchased and delivered in April 1994 the computer equipment required for the TEMPUS activities at MSFC. TMI also purchased and delivered in May 1994 an IBM compatible PC to support the TEMPEST Testbed in the UOF.



Teledyne Brown Engineering provided support to the UOF through the Space Station & Advanced Projects Office (FA23).

Task Order Number: 030:

Description: In order to expand flight opportunities for Microgravity Experimental Facilities, the Contractor will perform a search and trade-off study on all available orbital "Free-Flyers". Along with availability the specific tasks shall include: a) engineering assessment of Free-Flyer/Microgravity capability; b) method of orbital and retrieval; c) previous users; and d) other pertinent data deemed necessary for assessment by Microgravity Project Management.

Status/Deliverables: The work under this task, a study analysis, was performed with a sub-contract to CV Associates, Inc. Several sources were utilized in the analysis of the availability of various "Free-Flyers" including the SPACECOM database, the Teledyne Brown Engineering proposal on the "Free-Flyer" version of the MPESS for short or long term microgravity experimentation, the EURECA, and SPAS free-flyers. The study also included available information on Russian "Free-Flyer" equipment and accommodations. The results of the study were delivered to NASA in June 1994.

Task Order Number: 031:

Description: The Contractor will develop a 15-minute video on the TEMPUS for use by the MSFC Microgravity Projects Office and Space Sciences Laboratory. The video should cover the subject material at a level easily understood by non-scientific viewers.

Status/Deliverables: The TMI video team, assisted by Mr. Dave Dooling, developed the outline and script for the TEMPUS video. The script was reviewed and approved by MSFC. Interviews with six Principal Investigators (PIs) were taped. The video also included animation that was reviewed and approved by MSFC. An off-line version was produced and reviewed by MSFC. The recommended changes were incorporated and the video was produced and delivered to MSFC in July 1994 for use during the IML-2 Mission. IML-2 post flight changes were added to the TEMPUS video. The video was modified to reflect the experiments conducted on IML-2, the challenges encountered and how the PI team resolved them, and preliminary science results. The revision required some re-narration recording and reshooting of several PI's interviews. The final video included some additional footage acquired from the Johnson Space Center (JSC). The final TEMPUS video was completed in December 1994. Copies were produced

and distribution to MSFC followed in January 1995. A copy resides in the MPO Video Reference Library.

Task Order Number: 032:

Description: The Contractor will develop a 5-minute video on the RAMSES for use by the MSFC Microgravity Projects Office and the Space Sciences Laboratory. The video should cover the subject material at a level easily understood by non-scientific viewers.

Status/Deliverables: The TMI video team assisted by Mr. Dave Dooling, a TMI consultant, produced the outline and script for the RAMSES video. The script and required animation were reviewed and approved by MSFC. An off-line version was produced for review by MSFC PIs. Their recommended changes were incorporated and the video produced and delivered in July 1994 for use during the IML-2 Mission. IML-2 post flight changes were added to the RAMSES video. The final RAMSES video was completed and delivered to MSFC in October 1994. A copy resides in the MPO Video Reference Library.

Task Order Number: 033:

Description: The Contractor will provide general support which will include the preparation of review material for MSFC Microgravity Projects Office (FA24).

Status/Deliverables: TMI provided general support for MPO meetings including logistics, generation of name placecards, review material, and presentation charts.

Task Order Number: 034:

Description: The Contractor will provide an Engineering Aide for general support to the Chief Engineer's Office (EJ22).

Status/Deliverables: TMI provided engineering aide support to the Microgravity Chief Engineer's Office (EJ22) as required. This support included research, data compilation, drawings, charts, diagrams, document distribution and producing minutes of various meetings.

Task Order Number: 035:

Description: The Contractor will provide assistance in the preparation and publication of brochures required by the Microgravity Projects Office. This work includes the interviewing of PIs, reviewing technical materials, writing, photo search and selection,

brochure layout and design, and art mockups. Subjects of brochures will be assigned by NASA/MSFC.

Status/Deliverables: Mr. Dave Dooling, a TMI consultant, researched material in support of the brochure development for PCG-Mir, GFFC, and MGM. Mr. Dooling completed the PCG-Mir brochure including all revisions requested by NASA and delivered it in April 1995. A document for the PCG program entitled "Principal Investigator's Survival Guide" was developed. Corrections and changes were incorporated after a review by MSFC personnel and delivered to them in April 1995. Existing Protein Crystal Growth fact sheets were reviewed and revised to reflect experiments to be carried on ATLAS-3 (TES/COS and STES/VDA) and on the Mir Space Station. These fact sheets were delivered in October 1994. Press kit and fact sheet materials were prepared for STS-63 and STS-67 missions which were delivered in February 1995. Mr. Dooling also produced fact sheets for the USMP-3 mission.

Task Order Number: 036:

Description: Support the IR1 Furnace 1 Team in using the existing SSFF Brassboard system built by TBE. Including: Initial orientation to the existing system; consolidated training and demonstration testing; evaluate operational state of the equipment listing any discrepancies or problems; consulting on electronics control system and software design; recommend any needed additional spare parts, documentation, preventative maintenance and software as required, and be available for telephone consultation and meeting with IR1 Furnace Team.

Status/Deliverables: Teledyne Brown Engineering as a sub-contractor to TMI provided the MSFC IR1 Furnace 1 Team an orientation of the existing SSFF Brassboard system. A training session was held by Teledyne Brown Engineering for the MSFC IR1 Furnace Team. Additional support was also provided by Teledyne Brown Engineering on an as required basis.

Task Order Number: 037:

Description: Provide engineering support for requirements integration and planning for MSFC microgravity payloads to be flown on the Space Station. Including: review documents; assist with preparation and assessment of conceptual designs; perform engineering assessments; attend design reviews; define requirements to support engineering studies in response to action items for the Space Station and Advanced Projects Office of

MSFC; and coordination of planning for physical and analytical integrations of payloads, crew training, payload flight operations and issues supporting technical interchange meetings.

Status/Deliverables: Teledyne Brown Engineering as a sub-contractor to TMI provided engineering support on requirements integration and planning for MSFC microgravity payloads to be flown on the Space Station for the Space Station & Advance Projects Office (FA23).

Task Order Number: 038:

Description: The Contractor will gather and analyze data, develop formats, input data, and organize information to continue the SPACECOM Database effort. The Contractor shall suggest ways to organize, display, and update this database so as to maximize its utility and improve the process of maintaining the database. The Contractor will support MSFC in the following areas:

1. payload and experiment requirements
2. traffic models & mission requirements
3. engineering evaluations of design & accommodations
4. assessments of the use of NASA hardware in commercial applications
5. support of flight experiments assigned to MSFC
6. workshops, conferences & exhibits
7. documentation, reports, & brochures.

The contractor will gather, categorize, summarize, analyze, interpret, report, transfer, and present programmatic and technical information in assessing technology transfer projects. The Contractor will conduct surveys and interviews with industry, perform market opportunity analysis on selected MSFC technologies to determine potential industry benefit, and develop a database to track and manage problem statements received from the industrial community.

Status/Deliverables: Several consultants were utilized in the support to the Technology Transfer Office. The SPACECOM hard copy files were received from NASA, and the SPACECOM Database was established on TMI computers in our Perimeter Parkway offices during June 1994. This database was also modified to a format suitable for INTERNET.

Metrics to be used to measure technology transfer efforts at MSFC were identified and defined in June 1994. Also, the supporting data required and mechanisms for

acquiring the data were identified, and feedback questionnaires prepared during June 1994. These questionnaires were mailed to 871 industries during July 1994. Statistical information was acquired from Federal and State Agencies to support the development of models necessary to analyze the data received from industry. TMI assisted with the follow-up activities with industries to determine the impact of NASA technology on their companies. TMI personnel designed and developed a metrics database from which statistics could be generated. The metrics database design was discussed and coordinated with NASA Headquarters personnel. The metrics database was refined and implemented to support questionnaire feedback. The existing Problem-Statement database was translated and verified. Several adjustments had to be made to transfer the data into the metrics database correctly. As feedback was received from the questionnaires, the data was added to the metrics database.

The TMI video team edited and dubbed video tapes for the outreach sector of the Technology Transfer Office. TMI personnel created models, a chart package, and color view graphs and presented to NASA for input on the design of an educational conference room. The Payload Accommodations Handbook was reviewed and comments provided to NASA.

Task Order Number: 039:

Description: Provide the design and fabrication of three primary components and their integration into a GFE'd Experiment Apparatus Container (EAC). This integrated EAC Assembly shall be capable of performing ground development tests to measure the thermal performance of the Principal Investigators (PIs) sample. The primary components consists of a furnace Module Assembly (FMA), a Translation System (TS), and a Quench Collet Mechanism (QSM). Also, fabricate and assemble a sample exchange mechanism (SEM) with eight sample holders as designed in conjunction with MSFC personnel.

Status/Deliverables: A request for proposal was submitted to three companies for the Furnace Breadboard Fabrication. Wyle Labs and Microgravity Research Associates submitted an inability to respond due to current work loads. MSI responded with acceptable cost and schedule. MSI delivered to MSFC, per sub-contract to TMI, in December 1994 the furnace breadboard module, sample exchange mechanism, and dummy cartridges.

Task Order Number: 040:

Description: The Contractor will provide necessary personnel, facilities, and supplies and interface with appropriate personnel in the U.S. and foreign countries to determine and document design, capability, performance, resource requirements, extent of testing, availability, etc., to develop as complete an understanding as possible of the following flight hardware, in order of priority, AGHF, GFQ, LIF, Gallar, and CSK-4. Utilizing data and information developed above, the Contractor will analyze the design, operations, etc., of the hardware referenced above to determine potential utility of technology used that may be incorporated in furnace modules being developed for the SSFF. The Contractor will support the Microgravity Projects Office in planning, integrating, and operating this flight hardware in the joint US/Mir flights. The Contractor will also perform an experiment accommodations assessment to determine potential utility of this hardware by investigators presently in the microgravity sciences flight and flight definition program.

Status/Deliverables: TMI reviewed several documents relevant to the EXPRESS Rack Program and provided comments to the EXPRESS design team in June 1994. TMI personnel gathered the science requirements from the U.S. PIs and provided them to the AGHF CNES team in July 1994 in support of the AGHF's Phase 0/1 Safety Review. TMI assessed a top-level design of the United States Commercial Electrophoresis Program in Space (USCEPS). All issues were discussed with MSFC and Pennsylvania State University personnel. TMI compiled the data requirements for producing cartridges in a document entitled "Sample Cartridge Handbook" which was delivered to MSFC in October 1994. Various thermal analyses and analytical modeling efforts were accomplished throughout this task with the results of each delivered to MSFC and/or associated PIs. TMI developed a data processing tool to parse the data into temperature and gradient variations with respect to time producing output in plot format. The plots can be faxed directly to the U.S. PI and the results can provide insight into what the experimenter proposed in his design. This was used throughout this task and proved to be very beneficial to the PIs. Research was provided as required to assist the U.S. PIs with the development of their experiments.

TMI personnel developed a Materials Science Program Plan addressing the planning of Materials Science activities on the Space Shuttle and the Space Station. The plan was delivered to NASA in October 1994.

Task Order Number: 041:

Description: Perform a computational analysis of the voltage gradients of the high voltage load of the GFFC instrument. This analysis includes the Macor Base, Inner Sphere, Sapphire Dome, Teflon Baffle, the Viton O-ring, and the Outer Coolant Loop. This analysis is to determine what conditions will cause unwanted arcing and to determine whether the fixed physical geometry of the instrument components will allow arcing to occur even if all possible preventative measures have been taken.

Status/Deliverables: CFD Research Corporation as a sub-contractor to TMI performed a computational analysis of the voltage gradients of the high voltage load of the GFFC instrument. The report entitled "Potential Field Analysis of the Geophysical Fluid Flow Cell" was produced from the results of the analysis and delivered to MSFC in September 1994.

Task Order Number: 042:

Description: Provide Russian translation of English labels on Glovebox Hardware and produce the replacement labels in Russian. Provide a Russian translator for Glovebox interface meetings and translate to Russian a test procedure document and an operations manual for the Glovebox. Produce a 20 minute training video carrying the operations of the Glovebox Hardware as well as the student material.

Status/Deliverables: Russian translations were provided with the assistance of a consultant and labels produced for the glovebox trainer hardware prior to shipment to JSC. The Russian label templates were delivered to MSFC in January 1995. Additional Russian translations were provided to Teledyne Brown Engineering in January 1995 for the glovebox hardware documentation. Russian translations were provided to TBE for four glovebox experiments. Russian translations were provided and shipping labels produced for hardware shipping containers. These labels were delivered to MSFC in February 1995. TMI reviewed the preliminary draft of the US/R-04 document, Prelaunch Procedures, Status, and Configurations of the Mir Space Station to verify the Russian translations were consistent with the glovebox labels. Discrepancies were noted and reported to the Mission Management Office at JSC via MSFC MPO in March 1995. TMI met with Mir payload experimenters in April 1995 to verify the Russian translations they would be using on their hardware labels. TMI provided a consistency check between the translations used by the experimenters. A Russian translator was provided to support the MGBX unit qualification test meetings held at MSFC during May 1995. The Middeck Glovebox Acceptance Test

Phase I document and the Middeck Glovebox Operation and Maintenance Manual were translated into Russian. Translated copies of both documents were delivered to MSFC in May 1995. TMI produced the Glovebox Operations video script for review. Comments were received and incorporated. The updated script was approved. Video shooting was conducted in the TMI studio with the assistance of the MSFC engineer. Still shots were taped to load into the computer for use in the student material. The student material was developed, compiled, produced, reviewed by MSFC, and approved by MSFC. The Glovebox Operations video was produced in both PAL and SECAM formats. Ten copies of the video and the student material were delivered to MSFC in September 1995. An old glovebox decal was scanned in and some minor modifications were made per MSFC's direction. The revised glovebox design was used to have patches, decals, and two large foam mounted prints made. These items were produced and delivered to MSFC in September 1995 for use during the USML-2 Mission.

Task Order Number: 043:

Description: The Contractor will develop a 10-minute video covering maintenance of the Middeck Glovebox for use by the MSFC Microgravity Projects Office. The video will be used to train technical personnel in the details of servicing and maintaining the Middeck Glovebox Hardware.

Status/Deliverables: The TMI video team developed the Glovebox Maintenance video script. It was reviewed and approved by NASA. Video footage of the Glovebox hardware with a MSFC engineer narrating was filmed. The Glovebox Maintenance video was edited, produced, and delivered to MSFC in May 1995. A copy resides in the MPO Video Reference Library.



#### IV. CONCLUSIONS AND RECOMMENDATIONS:

The information presented in Section III shows that the TMI efforts have resulted in satisfactory completion of assigned Task Orders. The analyses and studies performed under various Task Orders provided scientific and technical data that has proven beneficial to microgravity efforts. In accomplishing these efforts, it became apparent that there are continuing and recurring needs for mission support to the Microgravity Projects Office (MPO). Examples of the Task Orders that need additional support are: 008, 019, 021, and 022. Comments on these Task Orders and their continuing and recurring needs are given in the following paragraphs.

It became obvious while working Task Orders 008 and 019 that a continuing need exists to inform the engineering and science communities about the accomplishments of the MSFC Microgravity Projects Office. To meet this continuing need, an effort focusing on three main objectives should be considered. The first and foremost should be the development of a source of information that reduces or eliminates duplication, stops bad information, and provides resources for developing new program efforts. This information should be consolidated and stored in a manner that is accessible by anyone that has a need or interest in microgravity research. Dr. Donald Fraiser MSFC/SSL made this suggestion as noted in a report relative to Task Order 019. The second objective should be to ensure MPO participation at meetings and conferences which have an emphasis on microgravity efforts such as crystal growth and benefits from space efforts. This participation would provide the opportunity to keep up with the various fields of research, and would lead to contacts that can be used to increase NASA - "outside" researcher collaboration. Dr. Byron Lichtenberg discussed this in more detail as a part of Task Order 008. The third objective is concerned with providing information at the meetings and conferences using an MPO exhibit that highlights one or more areas of concern of the MPO. This focus would obviously depend on the theme of the meeting or conference.

In order to meet these three objectives, the following is recommended. A formal working group should be formed under the auspices of the MPO. This working group, should consist of personnel from both government and industry. The working group or a subset of it, would be responsible for the details of the three objectives. It would not be necessary, nor cost effective, for all members of the working group to be involved in all aspects of the three objectives. For example, on the MPO exhibits for meetings and conferences, only MPO and their contractor would be involved. At the same time it may be necessary for all members of the working group to participate in forming one or more

sessions at a meeting or conference in order to get a desired emphasis of the MPO out to the engineering and science communities.

Results from the accomplishments of two additional Task Orders, 021 and 022, indicate a need relative to recurring and continuing efforts. From information provided to the MPO in Task Order 021, it is obvious that a major effort is needed to identify and establish dialogues with cognizant personnel who can provide additional information and required data on each Russian payload and the flight experimenters it has accommodated. A consolidation of such comprehensive information/data would allow researchers and commercial crystal growers to assess the applicability of identified Russian payloads for their experiments and the relevance of Russian flight investigations to their own experiment programs. The work called for here would be, or could be, a recurring effort that the working group, as previously defined, should accomplish.

As a result of the effort accomplished by TMI for Task Order 022 it is recommended that a comprehensive study of identified literature be made to extract all pertinent information on the influence of the acceleration environment in the space processing of materials. The result of this type of study should be detailed in comprehensive annual reports for use by the research and commercial community that specifies the effects of, and requirements and constraints imposed by, the acceleration environment in relation to each class of material processed and each crystal growth method employed in space. This recommendation could also be a part of the efforts of the previously defined working group.

TMI believes the information presented above, on efforts that need additional work, should be given serious consideration by the MPO. Therefore, it is recommended that MPO consider having these specified efforts included in any follow-on efforts or added to new efforts as appropriate.